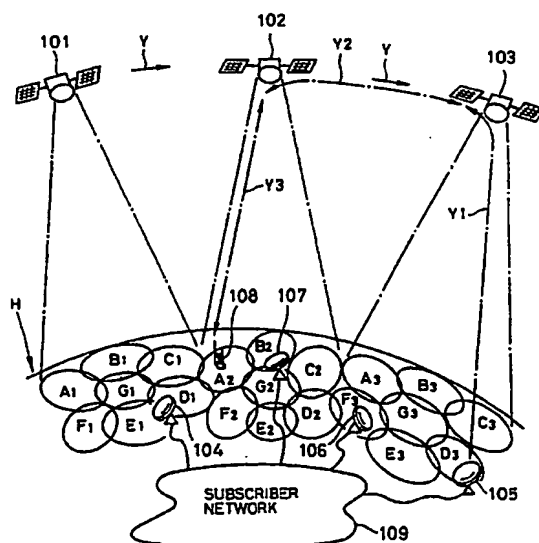


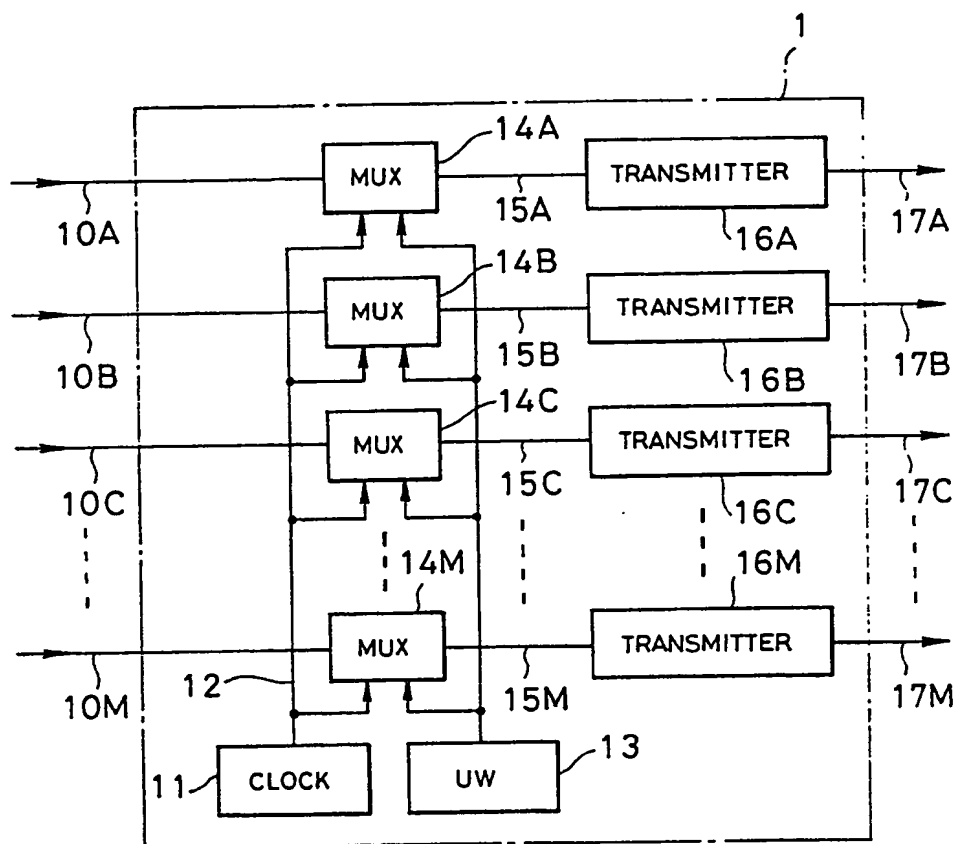
**(12) UK Patent Application (19) GB (11) 2 290 009 (13) A****(43) Date of A Publication 06.12.1995****(21) Application No 9510692.8****(22) Date of Filing 26.05.1995****(30) Priority Data****(31) 06119928****(32) 01.06.1994****(33) JP****(71) Applicant(s)****NEC Corporation****(Incorporated in Japan)****7-1 Shiba 5-chome, Minato-ku, Tokyo, Japan****(72) Inventor(s)****Hizuru Nawata****(74) Agent and/or Address for Service****Mathys & Squire****100 Grays Inn Road, LONDON, WC1X 8AL,****United Kingdom****(51) INT CL<sup>6</sup>****H04J 3/06 , H04B 7/212****(52) UK CL (Edition N )****H4M MTQA1****(56) Documents Cited****GB 1487689 A****GB 1286157 A****EP 0614289 A2****EP 0237972 A2****(58) Field of Search****UK CL (Edition N ) H4L LDC , H4M MTQA1 MTQX1****INT CL<sup>6</sup> H04B 7/204 7/212 , H04J 3/08****ONLINE : WPL INSPEC****(54) Collision avoidance in satellite communication system**

**(57)** In a communication system for transmitting and receiving burst signal between a round-trip satellite 101..103 and a ground station 104..107, upon transmission of a transmitting burst signal from the round-trip satellite, a standard time upon transmission is added to the transmitting burst signal. In the ground station (see figure 2), the time data added to the transmitting burst data is extracted and compared with the standard time upon reception to derive a transmission delay period. The transmission timing of a burst signal to be transmitted from the own station is controlled depending upon the transmission delay period. By this, even when a distance between the ground station and the round-trip satellite is varied, overlapping of the burst signals in the time slots on the same time axis can be successfully avoided. Also, a guard time can be shortened to contribute for improvement of the transmission efficiency.

**FIG. 5****GB 2 290 009 A**

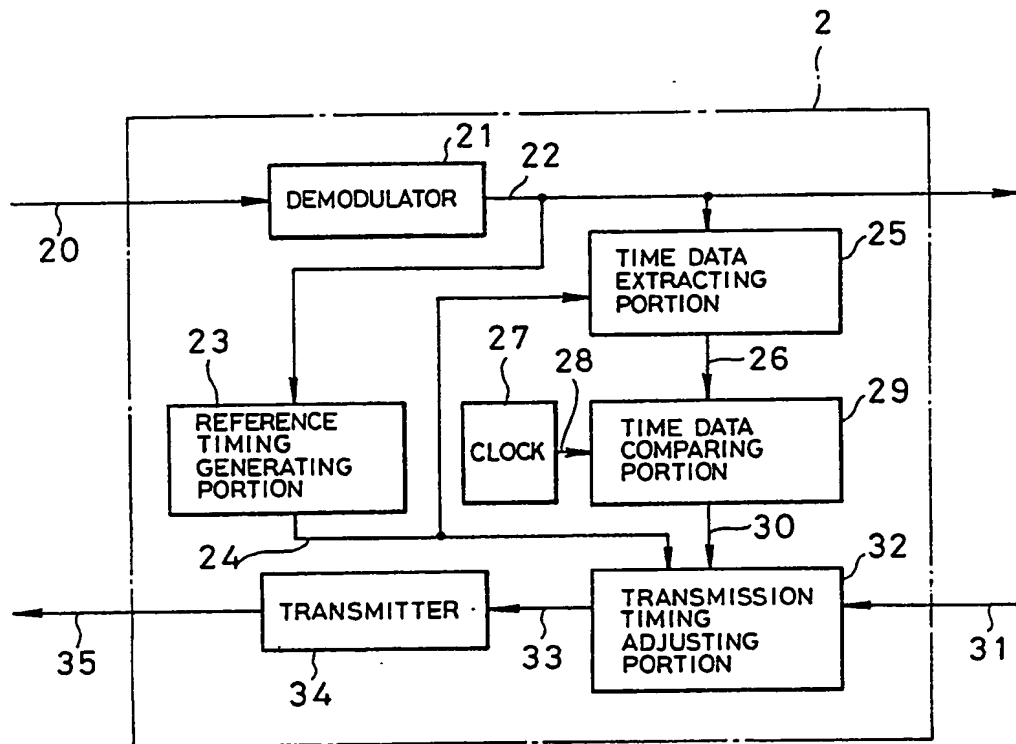
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FIG.1



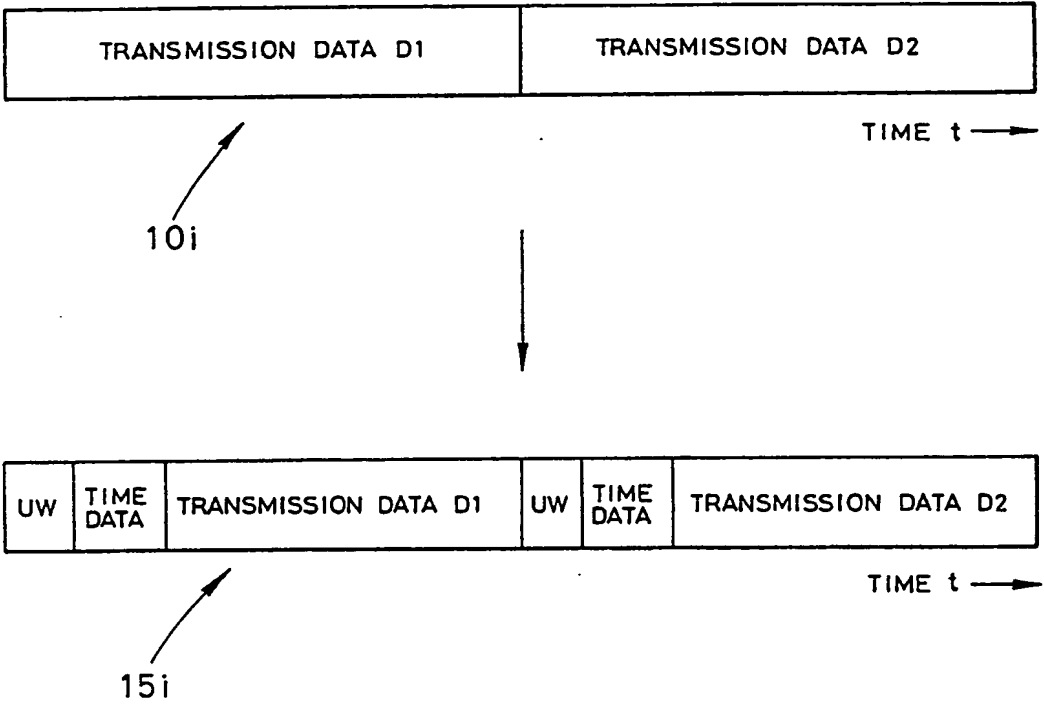
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FIG. 2



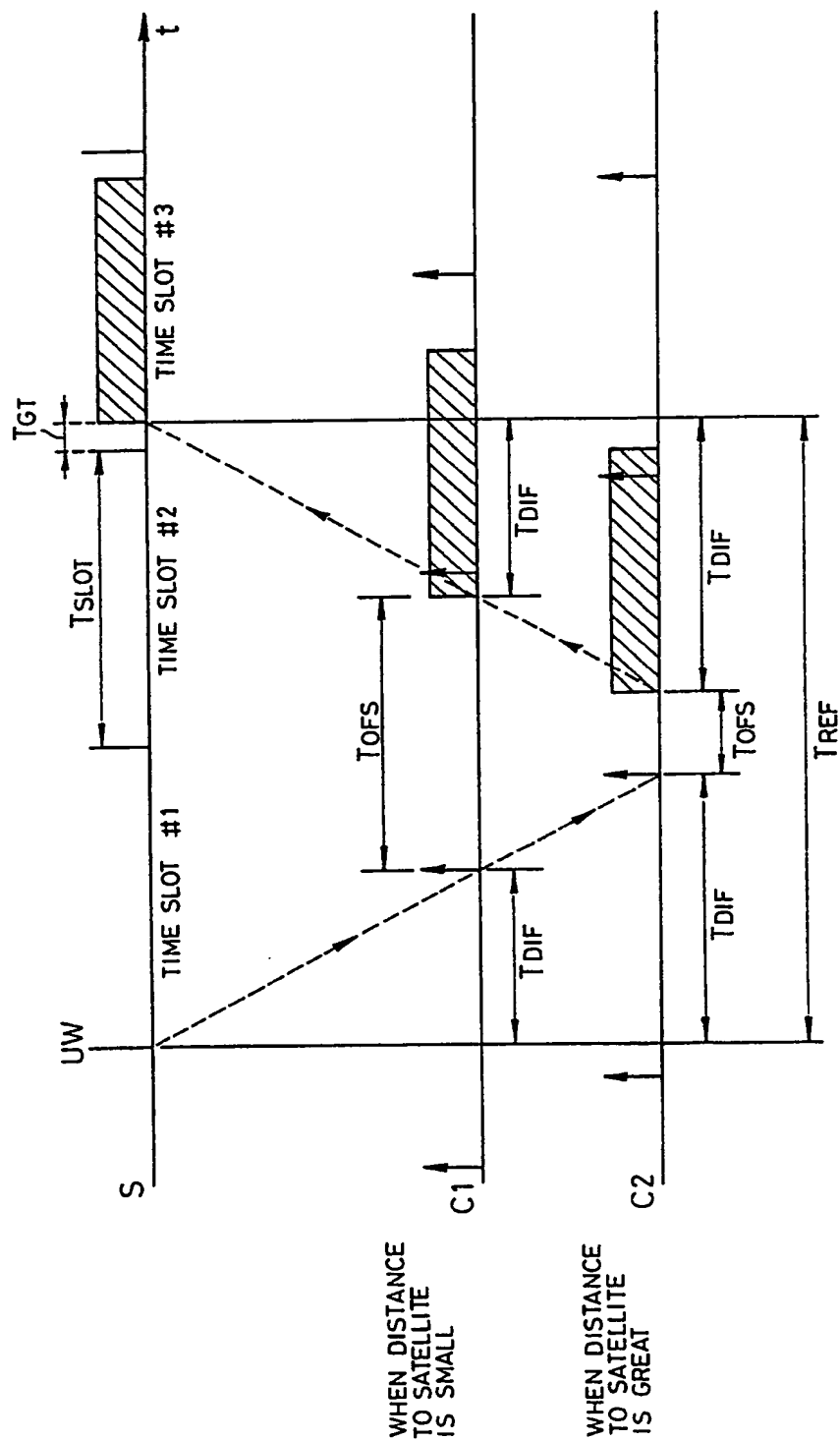
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FIG.3



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FIG. 4



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FIG. 5

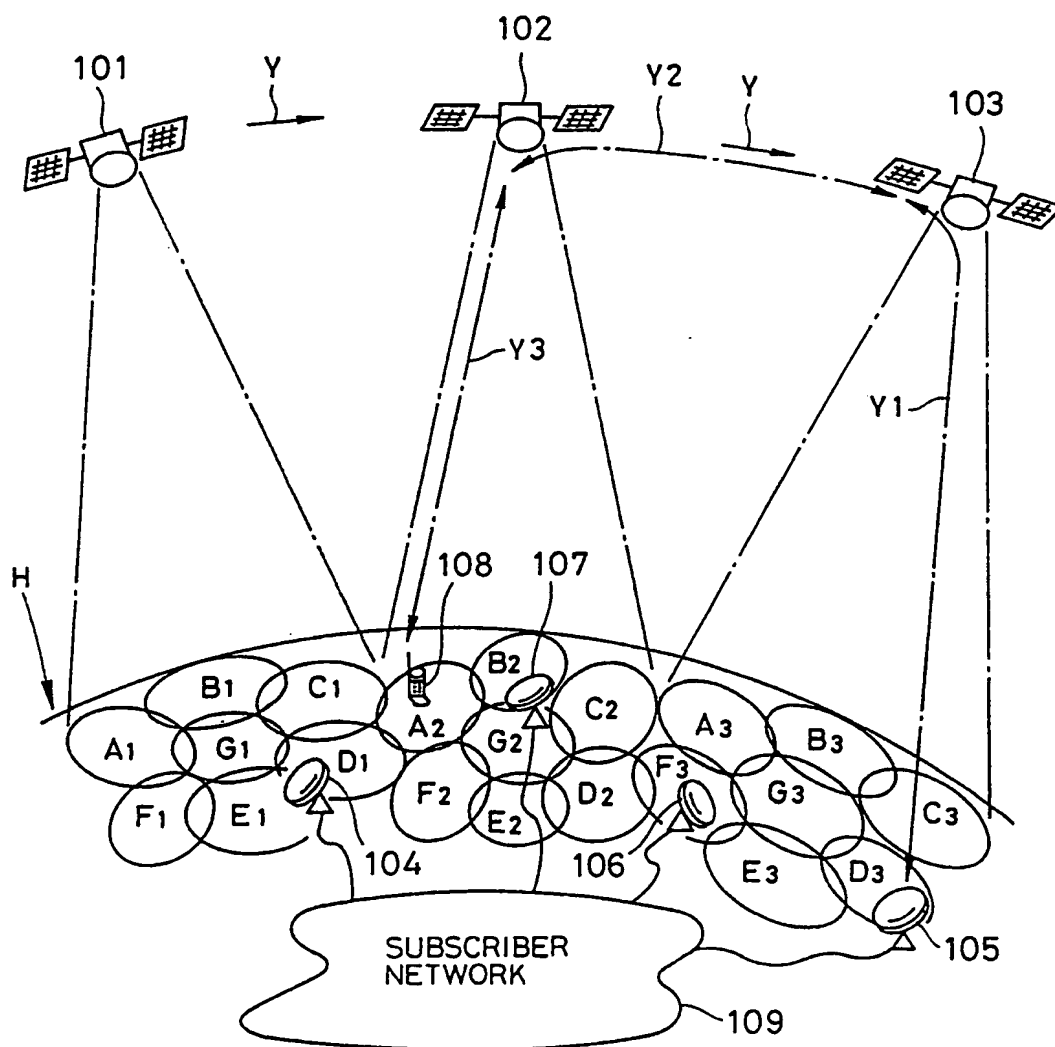
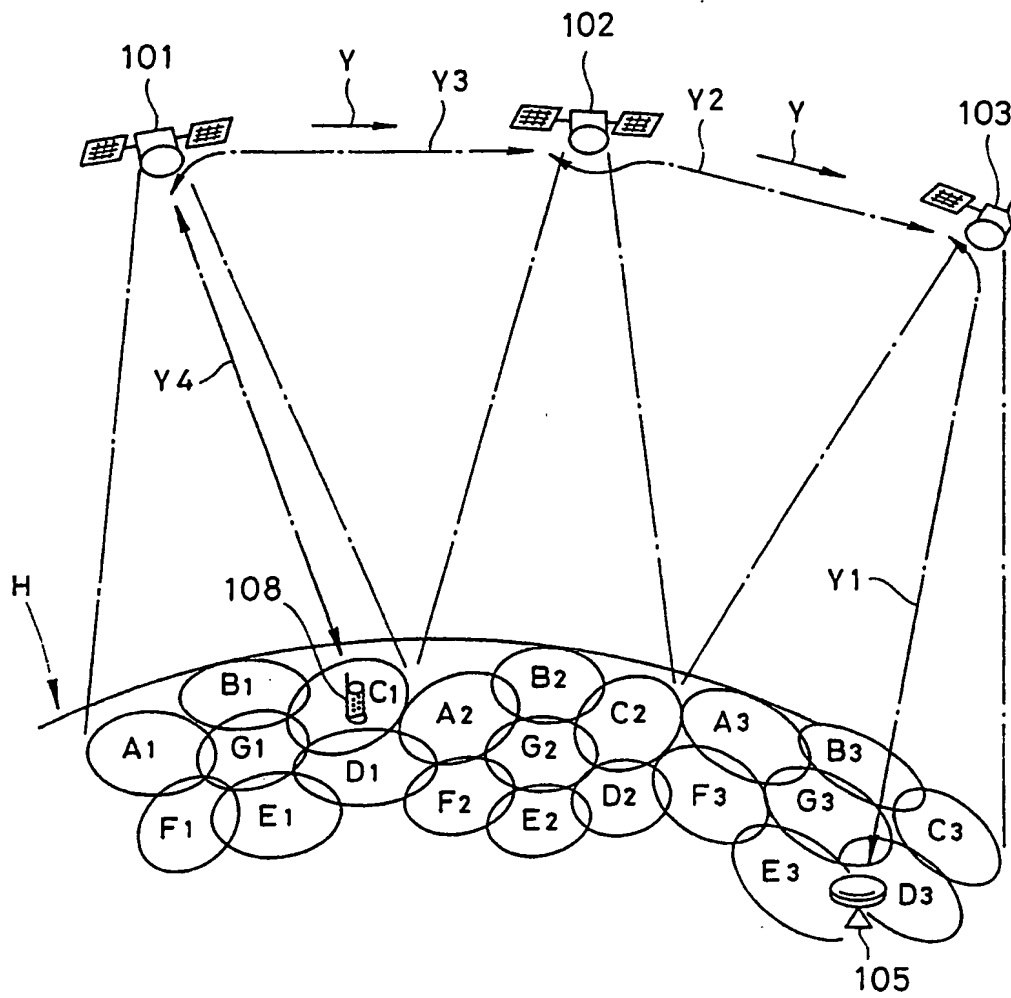
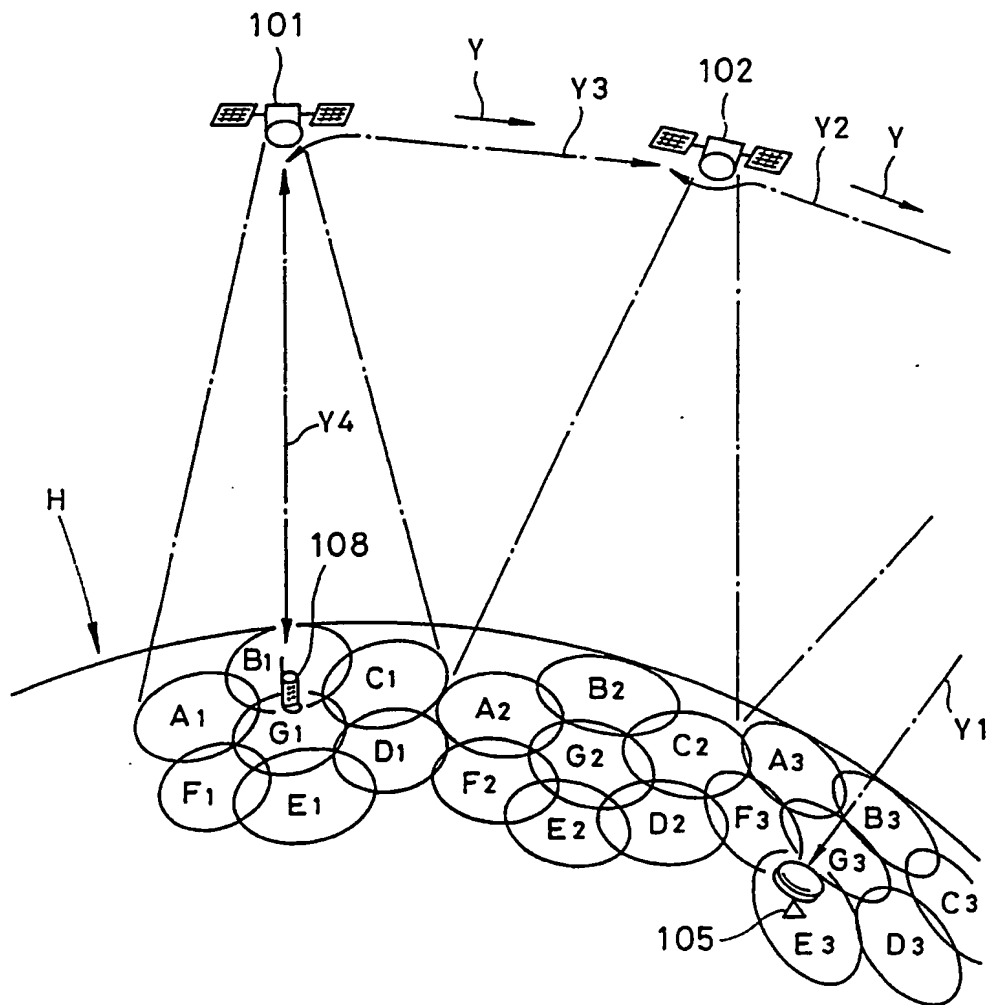


FIG. 6



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FIG. 7





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FIG. 8

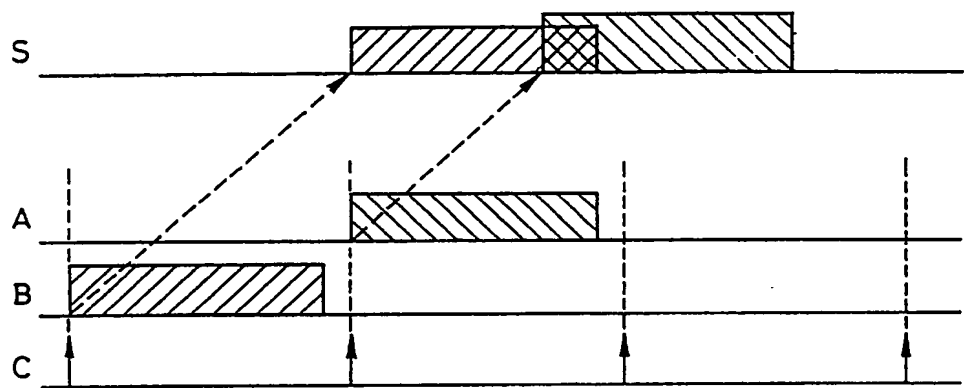
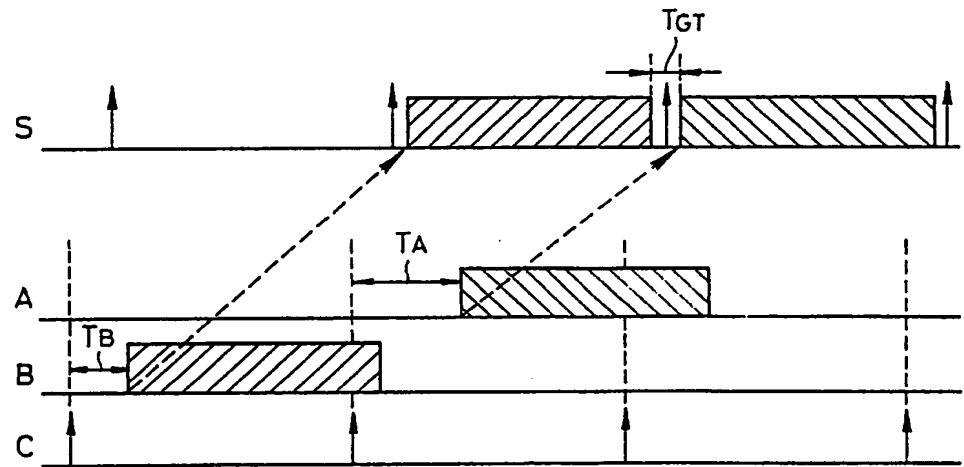


FIG. 9



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**COMMUNICATION SYSTEM****BACKGROUND OF THE INVENTION****Field of the Invention**

5           The present invention relates to a communication system. More specifically, the invention relates to a communication system for transmitting and receiving burst signal between a round-trip or a lower orbit satellite and a communication station, such as a  
10 ground station and so forth.

**Description of the Related Art**

A communication system in point-to-multi-point connection for communicating through a communication satellite typically uses a stationary satellite on a  
15 geostationary orbit. Since beginning of satellite communication in 1950s, it has also been proposed a system to perform communication through round-trip satellite group.

In the recent years, it has becoming possible  
20 to launching small size satellite economically for establishment of technology for launching small size satellite together with a large size satellite associating with enlarging of vehicle for the satellite, and also for development of a vehicle for launching the  
25 small size satellite. Accordingly, a satellite communication system employing low height level or middle height level round-trip satellite has been attracting

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attention.

Such satellite communication system is advantageous in comparison with the system employing the stationary satellite for lesser transmission delay and capability of down-sizing of a communication terminal. For instance, Iridium project of Motorola Corporation (U. S. A.) as introduced on "Nikkei Communication, Nikkei BP K. K. October 21, 1991, No. 12, pages 31 to 32 is one example of the system employing the round-trip satellite group.

Fig. 5 shows a network construction of typical satellite communication system employing low height level (lower orbit) round-trip satellite group. Here, 101 to 103 denote round-trip satellites, 104 to 107 denote network control stations present at least one in each area capable of communication to each of the round-trip satellites 101 to 103. The network control stations 104 to 107 serve as a gate station for connecting communication channel of the satellite to a subscriber network, charge management and management of network subscribers.

Among these, the control station 107 is a network base station managing whole network. 108 denotes a compact communication terminal which can be hand carried or installed on a transportation means by a subscriber, and 109 denotes the subscriber network. H denotes the earth.

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Each satellites 101 to 103 are satellites moving in the direction Y with irradiating spot beams. On the terrestrial surface, cells A1 to G1, A2 to G2, A3 to G3 are formed per respective spot beams. This is the cause why the satellite communication employing the round-trip satellite group is called as satellite cellular. As is well known in the terrestrial cellular, each cellular repeatedly use several mutually different frequencies for effective use of a frequency band. Also, by using the spot beam, power of the satellite can be efficiently used. On the drawings, there is illustrated a condition where communication is performed between the communication terminal 108 and the control station 105 as shown by arrows Y1 to Y3.

Each distance between center points to the satellite is differentiated per cell. Therefore, propagation time between the communication terminal and the satellite is differentiated per cell.

Fig. 6 shows a condition of the round-trip satellite group network after expiration a certain period from the condition of Fig 5. Namely, according to elapse of time, respective satellites have moved. Then, the communication terminal 108 located at a position within a cell A2 of the satellite 102 becomes to be placed within the cell C1 of the satellite 101. By this, communication as shown by arrows Y1 to Y4 is performed.

Fig. 7 shows a condition of the round-trip

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satellite group network after further expiration of the certain period from the condition of Fig. 6. In this condition, while the satellites have moved, the satellite to be used is held unchanged. Namely, the communication  
5 terminal 108 which initially placed within the cell C1 of the satellite 101, is now placed at the position within the cell B1 of the same satellite.

Thus, in the satellite communication system employing low height level round-trip satellite group,  
10 when continuous communication is to be performed, since the satellite moves relative to the communication terminal, a distance between the satellite and the communication terminal under communication varies from time to time. Therefore, signal propagation delay is  
15 also varied correspondingly.

On the other hand, when the communication terminal moves, cell, in which the communication terminal is present, may changed according to movement. However, this condition may also be considered that the satellite  
20 has moved relative to the communication terminal.

Here, in the satellite communication system employing the low height level round-trip satellite group, a system for dividing channel on a time axis with occupying a common frequency channel is employed. For  
25 example, a time-divided multi-access (TDMA) communication system or slotted aloha communication system and so forth. In these systems, a plurality of ground stations

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(communication terminals) distributed in a geographically wide area involved in the communication system have to transmit and receive burst signals. Accordingly, it is required that the burst signals transmitted from a plurality of ground stations are aligned on time slots in mutually not overlapping manner on a time axis on the communication satellite.

In order to align the burst signals from a plurality of ground stations on a plurality of time slots in mutually not overlapping manner on the time axis on the satellite, it becomes necessary to accommodate all of differences of propagation delay of the ground stations spread in wide area. For this purpose, it may be considered to set a guard time as long as possible in a unit time slot. However, this clearly degrades data transmission efficiency. Therefore, it becomes necessary to optimally adjust a "time shift" of a transmission timing to transmit the burst signal depending upon the magnitude of the propagation delay.

This will be discussed with reference to the drawings.

Figs. 8 and 9 are explanatory illustrations for aligning the burst signals on a plurality of time slots on the time axis on the communication satellite.

Fig. 8 shows the case where ground stations located at different places transmit the burst signals (hatched portions) according to a common reference

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transmission timing C. In this case, due to difference of the propagation periods to the communication satellite S from the grounding stations A and B, the burst signals are aligned on a plurality of time slots in partially overlapped condition on the time axis of the satellite S.

Fig. 9 shows the case where the ground stations located at different places transmit the burst signals (hatched portions) with adding own specific offset magnitudes  $T_A$  and  $T_B$  for the reference transmission timing C. In this case, even when the propagation delays from the ground stations A and B to the satellite are different, the burst signals may be aligned on a plurality of time slots without causing overlap on the time axis of the satellite S. It should be noted that TGT is a guard time between the burst signals.

Conventionally, the above-mentioned offset magnitude is linearly determined as a fixed values depending upon the positions of the ground stations, as set out in Japanese Unexamined Patent Publication (Kokai) No. Heisei 1-181336, left upper column, line 18 to right upper column, line 10.

When it is desired to continuously perform communication in the communication system employing low height level round-trip satellite group, since the satellites sequentially move relative to the communication terminal, the distance between the satellite and the communication terminal is varied

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according to elapsing of the time period. Thus, the propagation delay of the signal is varied.

In order to accommodate variation of the propagation delay, it is considered that the guard time TGT between the burst signals is increased. However, this inherently cause significant degradation of the transmission efficiency. Therefore, as set forth above, even when the burst signal is transmitted with adding own specific offset in a common reference timing, if the offset magnitude TA and TB in Fig. 9 are the fixed values, it cannot be adopted to variation of propagation delay according to elapsing of the time. Therefore, burst signals may cause mutual collision on the time axis of the communication satellite, to make it impossible to align the burst signals on a plurality of time slots.

#### **SUMMARY OF THE INVENTION**

It is an object of the present invention to provide a communication system which can solve the drawbacks in the prior art as set forth above and successfully avoid mutual collision of burst signals without causing lowering of the transmission efficiency.

According to a first aspect, the invention provides a method of communicating a burst signal between a communication satellite and a ground station, comprising:

receiving at the ground station from said satellite a burst signal including first timing data indicating the time of transmission thereof relative to a standard clock;

measuring at the ground station the propagation time of the received burst signal relative to the standard clock; and

transmitting a burst signal to the satellite from the ground station, with a transmission delay period controlled in dependence upon the measured propagation time of the received burst signal.

The invention also provides a ground station for a satellite communication system comprising:

means for receiving from a satellite a burst signal including first timing

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data indicating the time of transmission thereof relative to a standard clock;

means for measuring at the ground station the propagation time of the received burst signal relative to the standard clock;

means for transmitting a burst signal to the satellite from the ground station; and

means for controlling a transmission delay period of the transmitted burst signal in dependence upon the measured propagation time of the received burst signal.

According to a third aspect of the invention, a communication system for performing communication with a burst signal between ground stations via a communication satellite, the communication satellite including:

a first clock generating means for

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generating a time data matching with a standard time of the ground station; and

transmission means for transmitting the burst signal to be transmitted with adding a time data of the first clock generating means;

each of the ground stations including:

a second clock generating means for generating a time data matching with the standard time;

receiving means for receiving the burst signal transmitted from the communication satellite;

comparing means for comparing the time data added to the burst signal received by the receiving means and the time data of the second clock generating means; and

transmitting means for transmitting the burst signal to be transmitted from own station to the communication satellite with controlling a transmission delay period depending upon the result of comparison by the comparing means.

According to a fourth aspect of the invention, a communication system for communication between ground stations with a burst signal through a communication satellite, comprising:

the communication satellite including:

a first clock generating means for

10

- -

generating a time data matching with the standard time of the ground station; and

transmission means for transmitting the burst signal to be transmitted with adding a transmitting frame timing signal and a time data of the first clock generating means;

5

each of the ground stations including:

a second clock generating means for generating a time data matching with the standard time;

10

receiving means for receiving the burst signal transmitted from the communication satellite;

reference timing signal generating means for extracting the frame timing signal added to the reception burst signal received by the receiving means and generating a reference timing signal determining a transmission timing of a transmitting burst data of own station;

15

time data extracting means for extracting the time data added to the reception burst signal on the basis of the reference timing;

20

comparing means for comparing the extracted time data and the time data of the second clock generating means; and

25

transmitting means for transmitting the burst signal to be transmitted from own station

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to the communication satellite with providing a delay for a delay period depending upon the result of comparison by the comparing means.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5           The present invention will be understood more fully from the detailed description given herebelow and from the accompanying drawings of the preferred embodiment of the invention, which, however, should not be taken to be limitative to the present invention, but  
10       are for explanation and understanding only.

          In the drawings:

          Fig. 1 is a block diagram showing a construction of the major part of a round-trip satellite in the preferred embodiment of a communication system  
15       according to the present invention;

          Fig. 2 is a block diagram showing the major part of a ground station in the preferred embodiment of a communication system according to the present invention;

20       Fig. 3 is a conceptual illustration showing the case where a unique word and time data are inserted in a transmission data;

          Fig. 4 is a timing chart showing the operation of the preferred embodiment of the communication system  
25       according to the invention;

          Fig. 5 is an illustration showing a general construction of a typical satellite communication system

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employing a low height level round-trip satellite group;

Fig. 6 is an illustration showing a general construction of the satellite communication system after elapsing of a predetermined period from the condition shown in Fig. 5;

Fig. 7 is an illustration showing a general construction of the satellite communication system after elapsing of a predetermined period from the condition shown in Fig. 6;

Fig. 8 is a timing chart showing the case where burst signals are transmitted from a plurality of ground stations at different locations according to a common reference transmission timing; and

Fig. 9 is a timing chart showing the case where burst signals are transmitted from a plurality of ground stations at different locations with adding to an own specific offset magnitude to a common reference transmission timing.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be discussed in terms of the preferred embodiment with reference to the accompanying drawings, particularly to Figs. 1 to 4.

Figs. 1 and 2 are block diagrams of the preferred embodiment of a communication system according to the present invention. Fig. 1 shows the major portion of a round-trip satellite, and Fig. 2 shows the major portion of a ground station.

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In Fig. 1, round-trip (or lower orbit) satellites 1 in the shown embodiment are satellites having M in number of spot beams A, B, C, ....., M. The round-trip satellites 1 take transmission data 10A, 10B, 10C, ..., 10M independently input to respective spot beams as inputs, and transmit spot beam outputs 17A, 17B, 17C, ..., 17M.

On the other hand, the shown embodiment of the round-trip satellites 1 are provided with composite portions (MUX) 14A, 14B, 14C, ..., 14M corresponding to transmission data 10A, 10B, 10C, ..., 10M, and transmitters 16A, 16B, 16C, ..., 16M receiving corresponding outputs 15A, 15B, 15C, ..., 15M provided corresponding to respective composite portions and transmitting through modulation and amplification.

Furthermore, each of the shown embodiment of round-trip satellites 1 is constructed to have a clock portion 11 transmitting a time data consistent with a standard time on the earth, and a unique word generating portion 13 transmitting an unique word (UW) indicative of a timing to be a reference. Time data and unique word transmitted therefrom are inserted to corresponding transmission data 10A to 10M by the composite portions 14A to 14M.

On the other hand, in Fig. 2, the ground station 2 in the shown embodiment, is adapted to receive a modulation wave signal 20 transmitted from the round-

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trip satellites, and is constructed with a demodulator 21 receiving the signal 20 and performing demodulating operation, and a reference timing generating portion 23 detecting the unique word periodically inserted in the output data 22 of the demodulator 21 and generating a reference timing signal 24 to be the reference for transmission.

Furthermore, the ground station 2 in the shown embodiment is constructed with a clock portion 27 transmitting a clock data 28 consistent with the time data transmitted by the clock portion 11 in the round-trip satellites 1, a time data extracting portion 25 extracting the time data periodically inserted in the output data 22 of the demodulator 21 employing the reference signal 24, and a time data comparison portion 29 comparing the extracted time data 26 with a time data 28 generated by the clock portion 27 and outputting a time difference 30.

Furthermore, the ground station 2 of the shown embodiment comprises a transmission timing adjusting portion 32 deriving an offset amount by subtracting the time difference 30 output from the time data comparison portion 29 from the fixed value and transmitting a transmission data 31 to be transmitted at a timing delayed from the reference timing by the reference timing signal 24 in a magnitude corresponding to the offset amount, and a transmitter 34 receiving the output 33 of

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the adjusting portion 32 and transmitting the same with modulation. The output 34 is transmitted to the round-trip satellite.

The operation of the preferred embodiment of  
5 the communication system including the round-trip  
satellites 1 and the ground stations 2 constructed as set  
forth above, will be discussed as follow. At first, in  
Fig. 1, the round-trip satellites 1 irradiate M in number  
of spot beams and have transmitters 16 respectively  
10 corresponding to the spot beams. Also, the round-trip  
satellite internally includes clock portion 11 consistent  
with the normal time on the earth.

Respective transmission data 10A to 10M to be  
transmitted from respective spot beams are input to  
15 respective composite portion (MUX) 14A to 14M and are  
periodically inserted the time data 12 of the clock  
portion 11 and the unique word as the frame period signal  
indicative of the reference timing of the burst  
transmission in the ground station.

20 Fig. 3 shows an example, in which the unique  
word (UW) and the time data are inserted in the  
transmission data 10i (i = A to M). The transmission  
data inserted the unique word and the time data, namely  
the outputs 15i (i = A to M) of the composite portion 14A  
25 to 14M are fed to the transmitters 16A to 16M and then  
output with modulation and amplification. It should be  
noted that respective transmission data D1 and D2 are



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compressed in time axis.

Thus, since the time data at the time of transmission is inserted in the transmission data, the propagation delay period from the satellite can be measured by extracting the data in the ground station receiving the transmission data and comparing the extracted data with the time upon reception of the data. Namely, the difference of these times represents the propagation delay period from the satellite to the ground station, which propagation delay period becomes greater when the distance between the satellite and the ground station is large and becomes smaller when the distance is smaller.

Accordingly, by transmitting a burst signal by providing a delay from the reference timing for the offset amount corresponding to the propagation delay period, overlap of the bursts in the time slots on the satellite can be avoided. As a result, a guard time can be shortened. This effect in the ground station will be discussed hereinafter.

In Fig. 2, the ground station 2 demodulates the reception input 20 as the modulation wave by the demodulator 21 to attain the reception data 22. The reference timing generating portion 23 detects the unique word from the reception data 22 to generate the reference timing 24. Normally, this is performed by employing a technology for establishing frame synchronization.

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On the other hand, the time data extracting portion 25 receives the reception data 22 and extracts the time data 26 inserted in the reception data 22 according to the reference timing 24. The time data  
5 comparing portion 29 compares the extracted time data 26 and the time data (time data upon reception) from the clock portion 27 provided in the ground station 2 and outputs the time difference 30 (TDIF). Here, the clock  
10 portion 27 in the own station is of course matched with the same standard time to the clock portion 11 of the round-trip satellite 1.

The transmission timing adjusting portion 32 receives the time difference TDIF output from the time data comparing portion 29, calculates a value by  
15 subtracting a delay in reciprocation ( $2 \times \text{TDIF}$ ) from the fixed value TREF and sets the resultant value as the offset period TOFS. Then, the transmission data 31 is delayed from the reference timing 24 for the magnitude of the offset period TOFS. Namely, the offset period TOFS  
20 can be expressed by:

$$\text{TOFS} = (\text{TREF}) - (2 \times \text{TDIF}) \dots \dots (1)$$

Here, the fixed value TREF is the specific value  
25 determined with respect to the communication system and is a value derived by adding the guard time TGT to a integer multiple of a slot length T SLOT. Namely, the

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fixed value may be expressed by:

$$TREF = (N \times TSLOT) + (TGT) \dots \dots (2)$$

5                   The operation will be discussed with reference  
to Fig. 4. The reference timing to be generated by  
detecting the unique word transmitted from the satellite  
is delayed at greater magnitude as the distance between  
the ground station and the satellite. In Fig. 4, it  
10 should be appreciated that when the ground station 2  
transmits the burst signal to the third time slot No. 3,  
it becomes necessary to provide an offset from the  
reference time for a period derived by subtracting the  
propagation delay period required for reciprocation of  
15 the transmitted data to and from the satellite, namely  
double of TDIF ( $2 \times TDIF$ ), from the fixed value TREF  
derived by adding the guard time TGT to the period of  
double of the slot length TSLOT for transmitting to the  
average position of the time slot.

20                   When the distance to the satellite is shorter  
(reference transmission timing signal is shown as C1),  
the offset period TOFS becomes greater. Namely, when the  
difference TDIF of the time data is small, the offset  
period TOFS derived through the foregoing equation (1)  
25 becomes greater.

In contrast, when the distance to the satellite  
is greater (the reference timing signal is shown as C2),

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the offset period TOFS becomes smaller. Namely, since the difference TDIF between the time data is greater, the offset period derived through the foregoing equation (1) becomes smaller.

5           As set forth above, the transmission timing adjusting portion 32 performs transmission of the burst signal (hatched portion) with a delay for the offset period TOFS.

10           The transmitter 34 receives the transmission data 33 as the burst signal delayed by the transmission timing adjusting portion 32 and outputs the same with modulation.

15           As set forth above, in the round-trip satellite of the round-trip satellite system, the transmission data is transmitted with inserting the unique word and the time data of the transmission timing. Then, in the ground station, the time data is extracted from the received data and is compared with the time data upon reception so that transmission of the transmission data  
20           is delayed in the offset amount corresponding to the difference of the time data. Therefore, even in the round-trip satellite system, in which the propagation delay varies from time to time, the burst signals will never overlap to each other in the time slot. Therefore,  
25           the guard time can be significantly reduced. Therefore, transmission efficiency can be remarkably improved.

It should be noted that, while the foregoing

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embodiment has been discussed only for the case where the communication stations are the round-trip satellite and the ground station, the present invention should not be limited to the shown construction but is applicable for  
5 in the wide area, where the burst signals are exchanged between the communication stations.

As set forth above, according to the present invention, it becomes possible to construct the communication system which measures the transmission  
10 delay period from the first communication station to the second communication station to provide a delay in transmission of data from the second communication station to the first communication station to successfully avoid collision of the burst signals. Also,  
15 by shortening the guard time, transmission efficiency can be significantly improved.

Although the invention has been illustrated and described with respect to exemplary embodiment thereof, it should be understood by those skilled in the art that  
20 the foregoing and various other changes, omissions and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set  
25 out above but to include all possible embodiments which can be embodied within a scope encompassed and equivalents thereof with respect to the feature set out

in the appended claims.

To summarise, in a communication system for transmitting and receiving burst signal between a round-trip satellite and a ground station, upon transmission of a transmitting burst signal from the round trip satellite, a standard time upon transmission is added to the transmitting burst signal. In the ground station, the time data added to the transmitting burst data is extracted and compared with the standard time upon reception to derive a transmission delay period. A transmission timing of a burst signal to be transmitted from the own station is controlled depending upon the transmission delay period. By this, even when a distance between the ground station and the round-trip satellite is varied, overlapping of the burst signals in the time slots on the same time axis can be successfully avoided. Also, a guard time can be shortened to contribute for improvement of the transmission efficiency.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

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**CLAIMS:**

1. A method of communicating a burst signal between a communication satellite and a ground station, comprising:

receiving at the ground station from said satellite a burst signal including first timing data indicating the time of transmission thereof relative to a standard clock;

measuring at the ground station the propagation time of the received burst signal relative to the standard clock; and

transmitting a burst signal to the satellite from the ground station, with a transmission delay period controlled in dependence upon the measured propagation time of the received burst signal.

2. A ground station for a satellite communication system comprising:

means for receiving from a satellite a burst signal including first timing data indicating the time of transmission thereof relative to a standard clock;

means for measuring at the ground station the propagation time of the received burst signal relative to the standard clock;

means for transmitting a burst signal to the satellite from the ground station; and

means for controlling a transmission delay period of the transmitted burst signal in dependence upon the measured propagation time of the received burst signal.

3. A communication system for performing communication with a burst signal between ground stations via a communication satellite, said communication satellite including:

5 a first clock generating means for generating a time data matching with a standard time of said ground station; and

transmission means for transmitting the burst signal to be transmitted with the addition of  
10 time data from said first clock generating means;

each of said ground stations including:

a second clock generating means for generating time data matching with said standard time;

15 receiving means for receiving the burst signal transmitted from said communication satellite;

comparing means for comparing said time data added to the received burst signal

20 and said time data of said second clock generating means; and

transmitting means for transmitting the burst signal from the station  
to said communication satellite and for  
25 controlling a transmission delay period depending upon the result of said comparison by the



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comparing means.

4. A communication system as set forth in claim 3, wherein said transmitting means of said ground station is constructed to derive a doubled value of double of a time difference as the result of comparison by said comparing means, derive an offset value by subtracting said doubled value from a predetermined fixed value, and set said offset value as said transmission delay period for the burst signal to be transmitted.

5. A communication system as set forth in claim 3, wherein said fixed value is an integer multiple of the length of a time slot to be superimposed on said burst signal and a guard time length added thereto.

6. A communication system as set forth in claim 3, wherein said communication satellite is a lower orbit satellite.

7. A communication system for communication between ground stations with a burst signal through a communication satellite, comprising:  
said communication satellite including:

5 a first clock generating means for generating time data matching with a standard time of said ground station; and

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10           transmission means for transmitting the  
burst signal to be transmitted with adding a  
transmitting frame timing signal and a time  
data of said first clock generating means;

each of said ground stations including:

15           a second clock generating means for  
generating a time data matching with said  
standard time;

receiving means for receiving the burst  
signal transmitted from said communication  
satellite;

20           reference timing signal generating means  
for extracting said frame timing signal added  
to the reception burst signal received by said  
receiving means and generating a reference  
timing signal determining a transmission timing  
of a transmitting burst data of own station;

25           time data extracting means for extracting  
said time data added to said reception burst  
signal on the basis of said reference timing;

30           comparing means for comparing the  
extracted time data and said time data of said  
second clock generating means; and

transmitting means for transmitting the  
burst signal to be transmitted from own station  
to said communication satellite with providing  
a delay for a delay period depending upon the

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35                    result of comparison by said comparing means.

8.                    A communication system as set forth in claim 7,  
wherein said transmitting means of said ground station is  
constructed to derive a doubled value of double of a time  
difference as the result of comparison by said comparing  
5                    means, derive an offset value by subtracting said doubled  
value from a predetermined fixed value, and set said  
offset value as said transmission delay period for the  
burst signal to be transmitted.

9.                    A communication system as set forth in claim 8,  
wherein said fixed value is an integer multiple of the  
length of a time slot to be superimposed on said burst  
signal and a guard time length added thereto.

10.                   A communication system as set forth in claim 7,  
wherein said communication satellite is a lower orbit  
satellite.

11.                   A communication system as set forth in claim 7,  
wherein said transmission frame timing signal is a unique  
word.

12.                   A communication method, a ground station or a communi-  
cation system substantially as herein described with reference to  
the accompanying drawings.



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Patent  
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Application No: GB 9510692.8  
Claims searched: 1-12

Examiner: Simon Rees  
Date of search: 22 August 1995

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.N): H4M (MTQA1, MTQX1), H4L (LDC)

Int CI (Ed.6): H04J (3/06), H04B (7/204, 7/212)

Other: ONLINE: WPI, INSPEC

### Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB1487689A	(DIGITAL) Whole document, especially lines 39-69 of page 3.	1, 2,3,7
A	GB1286157A	(KOKUSAI/FUJITSU) Whole document, especially lines 16-41 of page 1 and lines 1-17 of page 5.	1,2,3,7
A,P	EP0614289A2	(NEC) Whole document, especially lines 25-37 of column 2.	1,2,3,7
A	EP0237972A2	(NEC) Whole document, especially from line 52 of column 3 to line 14 of column 4.	1,2,3,7

X Document indicating lack of novelty or inventive step  
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P Document published on or after the declared priority date but before the filing date of this invention.

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